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U. S. Department of the Interior, Oscar L. Chapman, Secretary
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Fishery Leaflet 374

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Washington 25, D. C. May 1950

FREEZING AND CANNING KING CRAB

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ABSTRACT

The techniques used in the preparation and handling of king crab are of primary importance in maintaining the quality of the canned or frozen product. King crab meat must be processed with utmost care to insure the maximum retention of color, flavor, and texture. A high quality product can be obtained only if careful attention is given to initial phases of handling the king crab such as holding the live crab, butchering, cooking, cooling, removing the meat, and cleaning. Recommendations are based on observations of experimental and commercial packs. Additional factors pertaining to packaging of meat for freezing and to heat processing are discussed.

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Introduction

One of the most recently developed and expanding fisheries on the Pacific Coast is the Alaskan king crab fishery. The king crab (Paralithodes camtschatica) is found in the cold offshore waters of central and western Alaska, extending from Prince William Sound to the Alaska peninsula and to the northern part of the Bering Sea. Present information indicates that the waters along the north side of the Alaska peninsula contain the best fishing areas. Prior to World War II, the Japanese were the principal exploiters of this fishery resource, utilizing large cannery ships accompanied by smaller fishing craft. Before 1940 the imports of the Japanese product formed the bulk of the domestic consumption of canned crab meat. American operations have been carried out on a small scale since 1927, but it is only in the last few years that an American fishery for these giant crabs has shown signs of permanent development.

The acceptance of quick-frozen king crab meat by the American consumer has provided much of the stimulus for production. In 1948 more than 200,000 pounds of the frozen king crab meat were produced in addition to 18,000 cases[1/] of the canned. Whereas the canning of crab meat requires considerable equipment and technical supervision in order to produce a quality product, frozen king crab meat may be produced with moderate expenditure for equipment and labor. This permits a refrigerated trawling vessel to utilize the fishery resource to advantage. Increasing competition and less favorable marketing conditions in other Pacific fisheries will attract more vessels to the king crab fishery. The present price for the product tends to offset the practical difficulties of operation in areas which are far removed from the ports and marketing areas. The practical aspects of the fishery, including operation of fishing gear, productivity of explored areas, and vessel requirements, were surveyed during 1940 - 41 and the data have been published in a report of the Alaska Crab Investigation[2/].

The experience gained from experimental and commercial operations in the last few years has demonstrated that the techniques in the preparation and handling of the king crab have a considerable effect on the quality of the canned or frozen product. King crab meat should be processed with utmost care to insure the maximum retention of color, flavor, and texture. A high quality product can be obtained only if careful attention is given to initial phases of handling the king crab, such as, holding the live crabs, butchering, cooking, cooling, removing the meat, and cleaning. Inasmuch as these operations are common to both frozen and canned packs, uniform recommendations can be made.

In addition, factors pertaining to the final process have been investigated. Although further research on the problems associated with the canning and freezing of king crab is desirable, all findings to date have shown the importance of the recommendations.

1/ One case contains 48 half-pound flat cans.

2/ The Alaskan King Crab, Fishery Market News, Vol. 4, No. 5a, May 1942 Supplement, Fish and Wildlife Service, Washington, D. C.

Initial Handling Operations

Sorting and Inspection of Live Crabs

The live crabs should be sorted immediately after catching in order to return the females and undersized crabs to the sea. Dead, crushed, and underweight crabs should be discarded. The tissue of the outer leg segments of old crabs which have not moulted for a long time appears to degenerate. These crabs usually have a thick, heavy, barnacle-covered shell which tends to be of a darker color. Experimental packs prepared from such crabs were of inferior quality in comparison with packs from the younger or firmer crabs. The cooked crab legs should be well filled; the meat should be firm, white with no yellowing, and bright red on the surface next to the shell. Cooked meat from recently moulted crabs tends to have a watery texture but has been found to be satisfactory for canning, except that difficulty may be found in obtaining a proper fill because of excessive shrinkage during processing. The yield of meat from such crabs is much less than that from crabs taken later in the season.

Holding the Live Crabs

The crabs should be butchered and processed the same day that they are caught. Any crabs which are dead when they reach the butchering table should be discarded.

Although crabs can be held alive on deck for periods up to 48 hours and longer, this practice is not recommended. Evidence obtained from the examination of experimental packs of both frozen and canned meat indicates that a loss of color and flavor is correlated with long holding periods. Discoloration caused by the coagulated blood and body fluids is more pronounced. A possible explanation is that even though the crabs are kept alive and wet with sea water, the accumulation of toxic products from the body wastes tends to affect adversely the quality of the meat noticeable after processing and storage.

Butchering

The carapace is torn off and the crab is split into two portions with the assistance of the butchering iron3/. The gills and viscera are trimmed away and the legs thoroughly scrubbed, using a strong stream of water to loosen adhering material. This step should be carried out with considerable care since contamination of meat with visceral material will cause discoloration and off flavors in the finished product. On the other hand, overzealous scrubbing and cleaning may result in a large loss of valuable body meat.

3/ A description and drawing of the butchering iron may be found in the report: "Experimental Fishing Trip to Bering Sea" by Joseph E. King, Commercial Fisheries Review, 11, No. 1, 3-13 (January 1949).

Cooking

The butchered crabs should be cooked by placing them in vats of boiling water for approximately 15 to 18 minutes. A batch-cooking process is preferable aboard ship. Continuous cookers present mechanical difficulties in moving the crabs at a uniform rate due to the surge caused by the roll of the vessel. The heating element of the cooker should be of adequate capacity in order that the water will resume boiling within a short time after the crabs are put in the vat. Overloading the cooker, cooking for long periods at low temperature, and undercooking are undesirable procedures. Overcooking tends to shrink the meat excessively and causes a loss of natural constituents. After cooking, the sections should be cooled quickly by dipping them in clean, cold water. This quick chill firms and shrinks the meat, making it easier to remove from the shell. Inadequate cooling allows further cooking of the segments and, as a result, the meat is difficult to shake from the shell. Fresh water, about a 3 percent salt solution, or sea water may be used for cooling. The use of sea water is most convenient and practical on small boats but it should be obtained only from open and uncontaminated waters.

Removal of Meat

The meat may be removed from the crab legs by either one of two methods. In the first method, the joint is torn apart and the soft part of the shell broken away to allow for shaking the meat out. The cartilaginous tendons remain fastened to the shell, and the meat is free of tendon. In the second method, the legs are sawed off on both sides of each joint and then shaken to remove the meat. This is simpler than the other technique; however, the tendons are left in the leg portions and there is a slight loss of meat at the joint. The shakers should remove the meat without undue destruction of the red membrane, since it is a distinguishing and desirable characteristic of the final product. Jamming or poking the meat from the shell, pulling the meat apart, and leaving bits of tendon and shell in or attached to the meat will lower the quality of the pack. Care in picking will simplify the task of washing and cleaning the meat to remove objectionable material. If desired for packaging, the whole leg meat should be separated from broken leg portions and body meat during this operation.

Washing, Cleaning, and Inspection of Meat

The curd-like coagulum of protein and blood, bits of shell, pieces of gills, tendon, and visceral particles should be removed as completely as possible during the washing, cleaning, and sorting of the meat. The appearance of the canned or frozen king crab will be affected considerably by the thoroughness of these steps. Any discoloration of the meat due to foreign matter becomes pronounced on processing. The meat is washed either by spraying with water under pressure or by immersion in clean water or weak brine with sufficiently rapid agitation to remove adhering material. The individual sections may have to be washed to remove excessive surface curd. Strong brine can be used for the bath, but in this case the period of immersion should be short so that excessive salt will not be absorbed by the meat. The operator should experiment to determine the most effective technique which insures adequate washing but does not result in excessive leaching or breakup of the meat.

The meat might advantageously be handled for washing, hand cleaning, draining, and inspection in shallow trays or baskets which allow thorough flushing of the meat and removal of the objectionable particles. Before further handling, the meat should be allowed to drain completely. Excessive water introduced into either a processed or frozen pack will produce a high apparent shrinkage or "drip."

Acid Treatment of Meat for Canning

In the canning of crustacea, it is common practice to treat the meat with an organic acid, such as acetic or citric, in order to minimize the possibility of discoloration of the meat due to the formation of iron sulfide. The meat may be treated either by dipping in a dilute solution of the acid or by adding an acid solution directly to the can. The final product should be slightly acid with a pH of 6.4 to 6.6.

The following treatments were tried with experimental packs of king crab meat and proved to be satisfactory:

1. Meat was dipped for 15 seconds in a solution of 2 ounces of glacial acetic acid to 1 gallon of water (approximately 1.6 percent acid by weight). Using 30-gallon batches of dip solution, 2½ ounces of glacial acetic acid were added after every 100 pounds of meat dipped. Proportionate amounts of acid should be added for a smaller volume of solution.

2. Meat was dipped for 15 seconds in a mixture of 27.5 ounces of saturated citric acid solution and 30 gallons of water (approximately 0.4 percent acid by weight). Nine ounces of saturated citric acid solution were added after every 100 pounds of meat dipped.

3. To each half-pound can was added 20 cc. of a solution of 1.5 ounces of glacial acetic acid, 14 ounces of salt, and 1 gallon of water. This solution is approximately 1 percent acetic acid and 10 percent salt by weight.

4. To each half-pound can was added 20 cc. of a solution of 1.3 ounces of saturated citric acid solution, 14 ounces of salt, and 1 gallon of water. This solution is approximately 0.7 percent citric acid by weight.

Comparison of sample packs by a laboratory taste panel indicated no marked preference for the flavor of the meat treated by any of the four methods. Only slight preference was shown for acid-treated packs in comparison with packs in which the acid treatment was omitted. Use of higher acid concentrations caused a pronounced acid aftertaste in the product. In no case did the use of added acid or acid dip appear to improve the color ratings of the samples when compared to experimental packs in which the acid treatment was omitted. Discoloration of the meat because of coagulated blood and protein curd was found uniformly regardless of acid treatment.

In using dip solutions, the proper concentration of acid must be maintained by replacing the acid absorbed by the meat. For best results, acetic or citric acid dip solutions should be discarded after 400 to 500 pounds of meat are dipped per 30 gallons of solution. The meat should be allowed to drain thoroughly before dipping in brine. If treatments number 3 or 4 are used, in which the acid and a brine solution is added, it is not necessary to season the meat in a separate step.

Brining

To season the product, the leg meat should be dipped for 15 seconds in a strong brine (90° salinometer or 24 percent salt by weight) made up with a high grade of salt. After the meats have drained adequately (approximately 5 minutes), they may be packaged for freezing. The body meat is not dipped in brine because it would absorb an excessive amount of salt for flavoring. Sufficient salt is absorbed by the leg meat to flavor the entire product. In the case of canned crab, brining usually follows the acid dip.

Possibility of Icing Crab Meat Aboard Ship

One experiment was made aboard vessel in which meat from the cooked king crab was packaged in number 10, friction-top cans, and held in crushed ice for 10 days. The meat was then repackaged in smaller containers, frozen, and stored at 0° F. Examination of the meat after arrival in port showed that a pronounced off flavor and odor due to incipient decomposition had developed, making the meat inedible. This was attributed to changes during the holding period in ice.

Packaging and Freezing

King crab meat is much more suitable for freezing than the meat of several other species of crab. Experimental packs of king crab meat stored at 0° F. for one year have been found to compare favorably in regard to flavor and texture with samples stored only two months. On the other hand, frozen dungeness crab meat when packaged in cellophane[4/] was unpalatable after storage for three months. Two important factors which lower the quality of the frozen king crab meat during storage at 0° F. are changes in color and in texture. Crab meat which has been carelessly cleaned or washed is apt to show considerable bluish discoloration after processing. Crab meat which has been packaged loosely with considerable air spaces in the package is likely to turn yellowish. The use of an impure grade of salt in making brines for flavoring or for adding to the meat in the package will cause yellowing of the meat after long storage periods. Only high grade salt, such as that specified for mild-curing salmon, should be used in preparation of the crab meat.

4/ Heerdt, Jr., Martin, Toughening of Frozen Crab Meat can be Retarded, Commercial Fisheries Review 9, No. 2, 7-10, (February 1947).

The second factor causing a loss of quality is that due to toughening of the meat. In order to minimize both toughening and discoloration, the crab meat should be packaged tightly in a moisture-vapor-proof container. Air spaces may be further eliminated by flooding the meat with pure water or, preferably, with a 2 to 3 percent salt solution.

Storage of frozen crab meat at higher temperatures of 10° to 15° F. caused undesirable texture changes and excessive "drip" on thawing compared to packs stored at a relatively constant temperature of 0° F. For prolonged storage up to 1 year a temperature of 0° F. or lower is most desirable.

King crab meat may be frozen in the shell, that is, the whole crab legs are frozen after butchering and cleaning. Although desirable for certain markets, king crab frozen in the shell is not as satisfactory for long storage as the packaged meat. Experimental samples of crab legs cooked before freezing have been stored at 0° F. for periods up to six months without marked changes in flavor and texture. A slight toughening of the meat and increased difficulty in removing the meat can be expected in lots stored for long periods. Only crabs in which the legs are plump and well filled should be utilized. Older crabs, whose shells do not indicate a moult for some time, are usually thin and have meat of poor quality. Crabs which exhibit evidence of a recent moult are apt to show poor recovery of meat. These should not be frozen.

The freezing and storage of raw crab legs is not recommended. After a short storage period of only three months, the raw meat becomes discolored and off-flavored. In addition, the raw meat is difficult to remove from the leg segments as it adheres tightly to the shell. Cooking the raw crab legs after freezing and storage increases the difficulty of removal of meat. The texture of such crab meat is inferior and is apt to be soft and slightly "mushy."

After freezing, the cooked crab legs should be ice glazed for storage; otherwise moisture is lost rapidly through the shell and texture and flavor changes will soon render the meat inedible.

Legs which have been cooked, frozen, and glazed aboard ship may be thawed to allow removal of the meat for packaging or canning. This offers possibilities for refrigerated fishing vessels that do not have facilities for further processing aboard. One objection to holding large quantities of frozen king crab in the shell aboard the vessel is that the pay load will be relatively small, inasmuch as the legs are bulky per unit of weight. At least 100 cubic feet of space per ton of crab legs are required for storage. The yield of butchered crab legs is approximately 50 percent meat by weight. Experimental packs of both packaged frozen crab meat and canned crab meat prepared from the frozen crab legs have been found to yield acceptable products. The meat from frozen legs utilized in this manner should be carefully inspected for discoloration or off flavors.

Canning

The final steps in canning king crab meat include filling the can, inspection, vacuum sealing, retorting, washing, and cooling[5]. The standard "½-pound-flat" can[6] with "C" enamel, seafood formula, is recommended for king crab. A fill of approximately 8 ounces is necessary in order to yield 6½ ounces of meat, drained weight. A vegetable-parchment paper liner is desirable but is not necessary. It must be emphasized that careful cleaning and packing of the meat is of primary importance for consumer eye appeal. Layers of leg sections on the bottom and top part of the can should be arranged uniformly. The body and broken leg meat is used to form the inner layer. The filled cans should be carefully inspected before sealing.

A vacuum sealing machine is recommended, but if one is not available, the cans may be clinched loosely and given a steam exhaust of 7 to 10 minutes at 212° F. before sealing. The sealed cans should be retorted as soon as possible. Several smaller retorts in the cannery are preferable to one large retort in order to allow more frequent cooks during the day. A processing temperature of 230° F. (6 pounds steam pressure) for 75 minutes is recommended. Higher temperatures tend to affect adversely the color and flavor of the product. After processing, the cans should be cooled quickly in order to prevent deterioration in quality. The hot cans should be washed quickly in a detergent solution to remove grease and foreign matter, rinsed, and plunged immediately into cold water. The cans may be stacked for drying in circulating air while slightly warm.

The production line for processed king crab should be a flexible unit adaptable to the handling of a highly perishable product. Undue delays at any point because of "bottlenecks" will cause loss of quality in the finished product. During periods of heavy fishing production it is recommended that packers do not lower the standards of the processing in order to increase the capacity of the production line.

5/ Further information on canning king crab can be found in the report "The Alaskan King Crab," Appendix III, Fishery Market News, Vol. 4, No. 5a, May 1942 Supplement, Fish and Wildlife Service, Washington, D. C. In addition, a publication valuable for general reference is "Principles and Methods in the Canning of Fishery Products" by Norman D. Jarvis, Research Report No. 7, Fish and Wildlife Service, Washington, D. C., 1943.

6/ The can maker's description is 307 x 201.25.

Summary

In general, the quality factors which have been enumerated are mainly those which depend on the experience and judgment of the operator. A specialty product, such as, canned or frozen king crab should be processed only under the highest standards in order to develop and maintain a permanent consumer market. It is unlikely that king crab will be produced cheaply under American labor standards, especially in view of the fact that the fishery lies far from the large Pacific fishing ports in areas of inclement weather. Only by keeping the interests of the developing industry in mind can one justify the increased cost of operation which is necessary if king crab is to be processed according to the high quality standards recommended. A reputation for quality established by the pioneers in the field will do much to maintain the stability of the industry in the future.

Acknowledgment

Acknowledgement is made to Norman Wigutoff, Fisheries Marketing Specialist, Fish and Wildlife Service, Ketchikan, Alaska, and to Carl B. Carlson, Chief of Exploratory Fishing Section, Pacific Oceanic Fishery Investigations, Fish and Wildlife Service, for assistance in compiling these recommendations and for preparation of experimental packs aboard the S. S. Pacific Explorer in the Bering Sea during 1948.

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